MarTREC

Maritime Transportation Research & Education Center

October 2015-September 2016

martrec.uark.edu

MESSAGE FROM THE DIRECTOR

The U.S. Department of Transportation's *Beyond Traffic 2045* draft report puts forth a set of challenges that our 22nd century transportation system will face if transportation leaders do not find innovative solutions to address these challenges. MarTREC's research is preparing our Nation's future transportation system for increased freight demand, growing population, aging infrastructure, and climate change by facilitating safe, secure, and environmentally-friendly multimodal freight movement in support of economic vitality. You will clearly see the advances our research faculty and students are making as you review this year's annual report. It is critical that we produce a next-generation workforce that is prepared to face and mitigate these challenges to ensure a resilient, safe, efficient, and effective multimodal transportation system. We are proud of this year's accomplishments and look forward to future contributions of our research projects and educational programs. We hope you enjoy reading our 2015-2016 annual report!

TABLE OF CONTENTS

MarTREC

Maritime Transportation Research & Education Center

RESEARCH

MarTREC conducts research activities in three research domains: 1) Maritime and Multimodal Logistics Management, 2) Building Resilient and Sustainable Multimodal Infrastructure, and 3) Livability and Emergency Management of Coastal and River Valley Communities.

VISION

MarTREC's theme is building economic competitiveness through efficient, resilient, and sustainable maritime and multimodal transportation systems. Our vision is to be recognized as the Nation's premier source for expertise on maritime and multimodal transportation research and education. Our MarTREC consortium was formed based on nationally-renowned expertise supporting the MarTREC theme, strategic location along a major navigable river or in a coastal area, and dedication to transferrable research and inclusive education and workforce development.

CONSORTIUM

Competitively funded in September 2013 through Map-21, the University of Arkansas, located in Fayetteville, AR, was awarded a Tier 1 Center entitled the Maritime Transportation Research & Education Center that focuses on building Economic Competitiveness. Our consortium consists of the University of Arkansas, Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University, Baton Rouge, LA; and University of New Orleans, New Orleans, LA. JSU is a Minority Serving Institution and AR, LA, and MS are EPSCOR States collaborating to meet the EPSCOR goal of stimulating competitive research.

MarTREC NEW PROJECTS

Climate Impacts on Lock Use and Performance

Justin Chimka, Ph.D.
University of Arkansas
July 2016-June 2018

It is the policy of U.S. Army Corps of Engineers (USACE) to integrate climate change preparedness and resilience planning and actions in all activities for the purpose of enhancing the resilience of our built and natural water-resource infrastructure (USACE Climate Preparedness and Resilience Policy Statement 2014). The US Global Change Research Program National Climate Assessment defines transportation sector components that are vulnerable to climate change, including fixed node infrastructure (ports), fixed route infrastructure (locks, canals/channels), and vehicles (ships, barges). Inland waterways may experience greater floods due to changing land-use patterns and precipitation, drought can lower vessel drafts, and less ice on navigable waterways could increase seasonal windows for passage. The objective of this work is to integrate resilience planning and climate change preparedness for water-resource infrastructure. Statistical models of Climate Impacts on Lock Use and Performance will help DOT and USACE integrate Climate Change Adaptation with Lock Operations and Marine Services by quantifying fixed route infrastructure vulnerability. The research steps will be to review literature, consolidate locks by district / division and / or waterway data for calendar years 1993 – 2015 and estimate generalized linear models (GLM) of annual tons locked by commodity group and lock, as a function of lock usage and unavailability, general characteristics of locks, and climate variables.

Corrosion-Tolerant Pre-Stressed CFRP Fatigue Retrofits for Improved Waterway Lock Reliability

Gary Prinz, Ph.D., P.E.
Clint Wood, Ph.D., P.E.
University of Arkansas
July 2016-June 2018

Retrofits for Improved Waterway Lock Reliability Locks are essential to waterway transport for many river and canal systems, allowing passage of ships through areas of differing water elevation. Over 23M cargo tons passed U.S. Army Corps of Engineers locks in January of 2015 alone, and 19 locks aid water transport throughout Arkansas, Louisiana, and Mississippi. These locks typically consist of large steel gates that are subject to large alternating forces as water levels are changed, and as lock gates open/close. Repeated loads, corrosive waterway environments, and component geometry can all contribute to fatigue/fracture issues that can limit lock gate service and inhibit the overall reliability of waterway transport. Unfortunately, fatigue issues within steel lock gate components are often only evident once the gates are emptied for routine service, or once serviceability is interrupted by structural failures. Lock service interruptions/repairs are costly (temporary repairs to the Montgomery Lock & Dam = $3.5M) but manageable from a fatigue perspective. The project addresses fatigue issues within lock gates, identifying critical components and exploring methods for preventing fatigue cracks for the entire gate component service life. The use of carbon fiber reinforced polymer plates will be explored along with innovative pre-stress and bonding strategies to fine-tune component stresses and achieve infinite component fatigue life.

Development of a Design Protocol: Sustainable Stabilization of Slope using Recycled Plastic Pin in Mississippi

Sadik Khan, Ph.D., P.E.
Jackson State University
May 2016-April 2017

The maritime and multimodal system is an integral part of the efficient movement of the nation's freight, which includes around 25,000 miles of commercially navigable harbors, channels, and waterways, 4 million miles of public highways and roads, and over 140,000 miles of national, regional, and local railroad networks. Slopes and embankments are one of the major components of the maritime and multimodal transportation infrastructure, which are often subjected to shallow landslides due to the existence of expansive clay soil. In Mississippi, the shallow slope failure is induced by the climatic (temperature and rainfall) variation that cause shrink-swell behavior of expansive Yazoo clay soil, and require significant budget to repair. As a cost effective alternative, Recycled Plastic Pins (RPP) can be utilized to stabilize shallow slope failures, to offer a sustainable option and increase the economic competitiveness to maintain multimodal transportation infrastructure. This study investigates the effectiveness of RPP to stabilize shallow slope failure on Yazoo clay in Mississippi, and develop a next generation design protocol based on the climatic variation of Mississippi, to maintain an efficient, resilient, and sustainable multimodal transportation system.

Evaluating the Performance of Intermodal Connectors

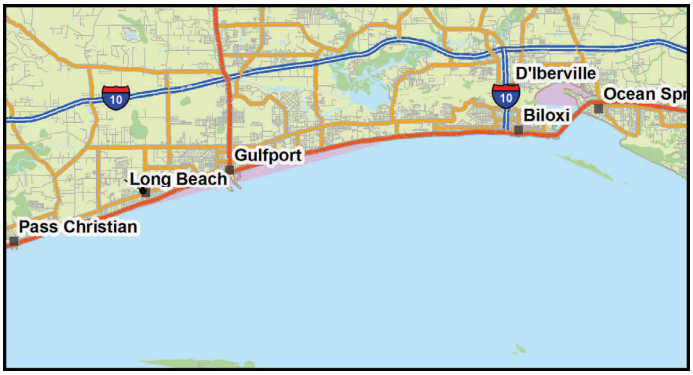
Sarah Hernandez, Ph.D.
University of Arkansas
August 2016-June 2018

This project focuses on evaluating the performance of Intermodal Connectors (IC)- critical "last mile" roadways connecting intermodal freight facilities such as maritime ports to the National Highway System (NHS). ICs account for less than 1% of NHS mileage, but are critical for timely and efficient multimodal freight movements. ICs are currently not well monitored or understood and are frequently missing from statewide planning, programming, and forecasting models. ICs are in relatively poor condition compared to the NHS as a whole. This has cascading effects on the reliability of multimodal freight operations- a 1- or 2-hour delay in a drayage movement can result in a 24-hour holdup in a domestic multimodal shipment. Continued economic growth and reliance on intermodal supply chains will further strain intermodal connectors if freight planning efforts do not effectively consider the use and performance of these critical network links. As a remedy, this project will instrument a selection of corridors and alternative routes serving the ports Van Buren, Little Rock, and Pine Bluff in Arkansas to gather comprehensive usage and performance characteristics. This project is timely given a recent assessment by the FHWA and MARAD which identified a number of shortcomings in current data collection methods, data availability and a lack of understanding in how IC performance affects local, regional and national freight movements.

Innovative Bio-Mediated Particulate Materials for Sustainable Maritime Transportation Infrastructure

Lin Li, Ph.D., P.E.
Jackson State University
November 2015-October 2016

Innovative bio-mediated particulate materials may provide great and previously unexplored opportunities as cost-effective and sustainable construction materials for maritime transportation infrastructure. The primary objective of this research project is to develop bio-mediated particulate materials to enhance the resilience and protection of maritime transportation infrastructure elements. The advanced materials are based on microbially-induced calcite precipitation (MICP) for the sandy soils in the coastal area. To address this need, and building upon its experience and expertise in the area, this project puts forth multidisciplinary effort to evaluate the mechanical properties of bio-mediated sandy soils attributable to the formation of MICP. Biological techniques, such as MICP, can provide unexplored opportunities for cost-effective, in situ improvement of the engineering properties of sandy soil. As one of the natural process in mineral precipitation, MICP by urea hydrolysis can result in relatively insoluble compounds contributing to soil cementation.



Measurement of Traffic Network Vulnerability for Mississippi Coastal Region

Feng Wang, Ph.D., P.E.
Jackson State University
November 2015-October 2016

Hurricanes are one of the most catastrophic events resulting in severe consequences including loss of life and property damage. The magnitude of devastation was evident in the hurricanes Katrina and Rita in the Gulf coast. The Mississippi Gulf coast region generally refers to the Gulfport-Biloxi-Pascagoula Area that consists of the Gulfport-Biloxi Metropolitan Area and the Pascagoula Metropolitan Area, including five counties and a joint population of about 400 thousand residents and 150 thousand families. This project will study the vulnerability of the coastal transportation network by applying stochastic game theory to the Mississippi coast region to provide the efficient connectivity measurement with on-demand applications in emergency situations. In a game theory approach, it is assumed that there are two opponents in a non-cooperative zero-sum game with symmetric information. One is the router, a benevolent player who seeks the shortest paths for all travelers, and the other is an evil tester who tries to disable edges in the network to maximally disrupt network performance.

Optimal Dredge Fleet Scheduling - Phase 2 Research

Chase Rainwater, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas
August 2016-August 2017

The excavation of US waterways, commonly known as dredging, is vital to our economy. Without navigable waterways, transportation of product may be disrupted. Oversight of dredging operations is a challenging problem because a decision-maker must (i) choose from numerous potential locations that are in need of dredging and (ii) schedule selected jobs within allowable environmental windows. In its simplest form, this series of decisions can be broken into two problems: (1) job selection problem and (2) job scheduling problem. Prior research projects supported by MarTREC and the Army Corps of Engineers, investigators Rainwater, Nachtmann and Sullivan have developed the first quantitative optimization tools to assist decision-makers with the a deterministic, one-year variant of the Job Scheduling Problem. This methodology has already been integrated into Corps computing systems. Previous work assumes that the decision-maker has been provided a preselected set of jobs for scheduling consideration. A quantitative system for comprehensive consideration of dredge job selection does not exist. The failure to integrate the selection and scheduling process suggests that opportunity exists for significant financial and operational benefits for transportation planners. This research seeks to provide new quantitative tools that address this need by leveraging the expertise developed in this area by the team of investigators.

Statistical Analysis of Vehicle Crashes in Mississippi Based on Crash Data from 2010 to 2014

Feng Wang, Ph.D., P.E.
Jackson State University
November 2015-October 2016

The current traffic safety situation in Mississippi has been of great concern. The Mississippi Department of Transportation crash dataset shows that more than 640,000 traffic crashes on Mississippi highways were recorded over the period from May 2010 to February 2014. The National Highway Traffic Safety Administration of the U.S. Department of Transportation has identified the following major causes for traffic crashes: 1) DWI (driving while intoxicated); 2) Speeding; and 3) distracted driving. Models have been built to analyze the vehicle crashes for major highways in the Mississippi coastal area. We are applying the models to crashes on multiple highway corridors and have developed machine learning algorithms to identify traffic crash hot spots on US 49.

Quantification of Multimodal Transportation Network Vulnerability: A Pilot Study in Mississippi

Himangshu Das, Ph.D., P.E.
Jackson State University
May 2016-April 2017

There are pressing needs to develop a network based quantification framework to assess vulnerability of multimodal transportation and infrastructure network exposed to both natural and man-made hazards. The objective of this study is to identify critical transportation networks and its vulnerabilities to a wide variety of hazard conditions based on real-world data. Three research questions will be addressed: 1) possible scenarios of future climate changes with respect to projected sea level rise and changes in storm surge intensity specific to the Mississippi coast; 2) inventory of critical transportation infrastructures; and 3) sustainability and effectiveness of the transportation network under possible hazard conditions. The objectives will be accomplished through systematic inventory of transportation facilities in Mississippi and prognostic modeling of infrastructure vulnerability using network model. We believe that the outcome of this study will be cursory towards developing a comprehensive design, adaptation and mitigation framework for the state and metropolitan area to address risk and vulnerability of Mississippi's transportation infrastructure due to hazards.

Quantifying Resiliency of Maritime Transportation Systems

Brian Wolshon, Ph.D., P.E., PTOE
Louisiana State University
October 2015-May 2018

Worldwide, maritime transportation networks facilitate the movement of nearly 90 percent of total world trade and 60 percent of global fuel and oil delivery. In 2011, US foreign and domestic waterborne trade totalled more than 2.1 billion metric tons of goods, with 62.5 percent of this total bound for international destinations. This total also accounted for about 15 percent of total global waterborne trade activity. Waterborne shipping has increased at an average annual rate of nearly one percent between 2009 and 2012. This research is leveraging and adapting archival National Association of Independent Schools data for resilience analyses of coastal port operations following disruptive events. The primary contribution of this research is that it represents first steps toward creating a systematic, objective means of measuring commercial port resiliency. The methods developed can be used as a basis for future studies of post-disaster operations and protocols, such as evaluations of channel operations after a disruption so as to better understand characteristics that increase resiliency.

MarTREC ONGOING PROJECTS

Dynamic Decision Modeling for Inland Waterway Disruptions

Shengfan Zhang, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas
August 2014-December 2016

There is much uncertainty associated with inland waterway transportation. Natural or man-made disruption on the inland waterway system can have widespread economic and societal impacts, and their consequences can be significant. There are various sources of uncertainty associated with the disruptive events (e.g., extreme weather conditions) that make the decision process difficult. As an example from the perspective of a barge owner, in the case of a disruptive event, uncertainty in the system makes it difficult to determine if it is optimal for the barge to stay on the water and wait for the locked traffic to clear, or if it is more economical to redirect to rail or freight transportation. In this research, we are developing a stochastic decision making framework to determine the optimal decisions from a barge owner's perspective during a disruptive event.

Efficient Dredging Strategies for Improving Transportation Infrastructure Resilience

Kelly Sullivan, Ph.D.
University of Arkansas
August 2014-December 2016

The viability of the inland marine transportation system is dependent upon highly random processes including weather, shoaling, and lock degradation. This project, seeks to determine efficient uses of maintenance dollars by developing mathematical modeling approaches to explore cost-efficient maintenance strategies for hardening inland waterway infrastructure against the possible impacts of shoaling and weather events. Research objectives are: 1) develop mathematical models to assess the cost of transporting multiple products from origin to destination of fixed channel depths 2) develop a static model for allocating budget resources for the completion of scheduled and unscheduled maintenance dredging projects 3) extend the models of the previous objective to allocate maintenance budgets dynamically over time considering uncertain weather and shoaling. Preliminary findings from our research have been presented at the November 2015 INFORMS meeting in Philadelphia, PA, and the May 2016 Industrial and Systems Engineering Research Conference in Anaheim, CA.

Evaluating Coastal and River Valley Communities Evacuation Network Performance Using Macroscopic Productivity

Scott Parr, Ph.D., E.I.T.
Louisiana State University
May 2015-April 2017

Coastal and river valley communities are particularly vulnerable to catastrophic events due to their proximity to large bodies of water. A robust and resilient transportation system is therefore imperative in these communities to mitigate the added risk of flash flooding, hurricanes, storm surge, and sea-level-rise. Evacuation planning and by extension, evacuation modeling is one tool available which can assist in the mitigation of this risk and ultimately lead to a more resilient transportation system. The simulation of mass evacuation traffic processes, while enormously valuable in emergency planning and management, presents a number of challenges to transportation modelers and analysts. In this research, an optimization model was proposed to maximize evacuation throughput traffic for regional networks. This model aims at optimizing network outflow and trip complete percentage at a macroscopic level by changing the distribution of evacuation traffic in the time horizon.

Photo courtesy of AHTD

National Inventory and Analysis of Transit Oriented Development in Proximity to Coasts and Port Facilities

John L. Renne, Ph.D., AICP
University of New Orleans
October 2013-September 2017

There is often a tension between the development of mixed-use transit oriented developments and heavy industry near coastal areas and major rivers and near port facilities. The study will quantify and examine the number of jobs and residents in station areas near coastal areas, major rivers, and near port facilities across the United States and forecast future development and job potential of underbuilt station areas. The research objective is to identify the number and type of jobs located in all types of stations and compare and contrast by typology.

Rapid and Non-Destructive Assessment of Levees for Strength and Liquefaction Resistance

Clinton Wood, Ph.D., P.E.
Michelle Bernhardt , Ph.D.
University of Arkansas
January 2015-December 2016

The goal of this research is to develop a rapid, non-destructive geophysical testing program and probabilistic framework that can be used to proactively evaluate levees. A comprehensive literature review has been compiled which identified main levee failure mechanisms, the corresponding defects associated with these failures mechanisms, and the non-destructive geophysical methods that have been used to detect these defects. A small earthen dam has been tested using surface wave methods and resistivity in association with Natural Resource Conservation Service. The Mel-Price Wood River Levee System along the Mississippi River outside St. Louis, Missouri was tested in July using surface wave methods and resistivity. Results are being processed and will be compared to boring logs and cone penetration measurements taken along the levee. The PIs are working with researchers from the University of Texas at Austin National Science Foundation Natural Hazards Engineering Research Infrastructure site to host a field workshop on the non-destructive evaluation of levees.

Supporting Secure and Resilient Inland Waterways

Heather Nachtmann, Ph.D.
Justin Chimka, Ph.D.
University of Arkansas
August 2014-June 2017

To mitigate inland waterway disruption impacts, we developed the cargo prioritization and terminal allocation problem (CPTAP) to minimize the total value loss of disrupted barge cargoes. CPTAP was initially formulated as a nonlinear binary integer program, and problems of realistic size were efficiently and effectively solved with a heuristic approach. The final solution will identify an accessible alternative terminal for each disrupted barge and the prioritized offload turn that each barge takes at its assigned terminal. Implementation of CPTAP results reduced cargo value loss and response time when compared to a naïve minimize distance approach. We are currently extending our earlier work through CPTAP model enhancement in order to provide timely knowledge and awareness of what cargoes should be prioritized for offloading during disruption response and what infrastructure exhibits low resiliency in terms of modal capacity to potential attacks or natural disasters against inland waterway transportation systems. We have formulated and tested a linearized version of the CPTAP model which shows result improvements compared to our initial approach. Our ongoing work will refine and optimize this new solution approach. This project was presented at the 4th Biennial TRB-CMTS Conference in Washington, D.C. in June, 2016.

Vulnerability of Fuel Distribution Systems to Hazards in Coastal Communities

John Pardue, Ph.D., P.E.
Louisiana State University
May 2015-December 2016

Coastal communities are vulnerable to disruptions in fuel availability for their transportation networks due to their susceptibility to flooding and storm surge events. This study examines fuel distribution disruptions from past storms and the time for restoration of fuel availability after coastal hazard events. Causes and mitigation of damaged fuel networks will be determined and new designs and methods proposed to minimize disruption during coastal hazards.

MarTREC COMPLETED PROJECTS

Development of a Large-Scale Traffic Simulation Model for Hurricane Evacuation of Mississippi Coastal Region

Feng Wang, Ph.D., P.E.
Jackson State University
July 2014 - July 2015

This study developed an optimization model to obtain improved traffic flow assignment with a minimization of the total travel cost in a localized no-notice evacuation network. In this study, we made the following observations: (1) numerical results show that the implementation of a gate control strategy that increases the capacities of the inbound and outbound links of the selected node(s) on the Protective Action Zones (PAZ) boundary and reduces the capacities of the inbound links to the non-gate nodes on the PAZ boundary could effectively decrease the total travel cost and reduce the degree of conflicts related to traffic movements and trip routes inside the network PAZ by guiding the evacuees to evacuate from the PAZ through the gate nodes on or near the PAZ boundary, (2) experimental results show that in a no-notice or short notice evacuation for a PAZ, in which node(s) on the boundary are selected for gate control impacts the evacuation performance, the number of nodes selected for a gating strategy may also impact the evacuation performance, and (3) traffic simulations of an evacuation scenario with a large scale network show that applying the gate control strategy could improve evacuation performance.

Economic Impacts of Lock Usage and Unavailability

Justin R. Chimka, Ph.D.
University of Arkansas
August 2014-June 2016

Freight statistics should provide an objective baseline for transportation policy decisions, and national economic benefits of maritime transport necessitate improving inland waterways infrastructure. This work included consolidating and learning from Lock Use, Performance, and Characteristics data collected by the U.S. Army Corps of Engineers (USACE) and published by the Navigation Data Center. The research

objective is to estimate annual tons locked by commodity group and lock, as a function of lock usage and unavailability (1993-2013). Usage data includes average delay and processing time, barges empty and loaded, flotillas and vessels, lockages, and percent vessels delayed. Unavailability data includes scheduled and unscheduled lock unavailabilities, and unavailable times. Estimation required consolidation and statistical models of Lock Use, Performance, and Characteristics published by the USACE Navigation Data Center. Results include effects of lock usage and unavailability on tons locked by commodity group (coal, petroleum, chemicals, crude materials, primary manufactured goods, food, and manufactured equipment). Twenty-two out of the 42 datasets resulted in at least one useful subset where we could employ our alternative to stepwise regression to find a linear model which is efficient and practically appropriate according to our definitions of those characteristics. We are currently extending the project to study Climate Impacts on Lock Use and Performance.

Exploration of Novel Multifunctional Open Graded Friction Courses for In-situ Highway Runoff Treatment

Yadong Li, Ph.D., P.E.
Lin Li, Ph.D., P.E.
Jackson State University
July 2014-June 2016

Pollutants on roadways and parking lots can come from various sources, including the deposition of exhaust, fluid leakage from vehicles, abrasion from the

friction between tires and roads, abrasion from brake pads, deicing activities, atmospheric deposition, corrosion of crash barriers, and pavement itself. Storm water runoffs from roadways contain both organic and inorganic contaminants of which large portions are eventually conveyed to the nearby water bodies such as rivers and lakes. Copper (Cu) and Zinc (Zn) have been identified to be the major inorganic contaminants in roadway runoffs. The goal of this study was to examine the removal of the major heavy metals Cu and Zn in roadway runoffs through pervious concrete pavement (PCP) and Modified PCP (MPCP) and by adding innovative additives to Open Graded Friction Courses to create a new material that has high heavy metal removal capacities. The results of this study bring an important conclusion that not only can the pervious concrete pavement bring traffic-related benefits but also environmental benefits because of its long-term removal capacities for Cu and Zn, which are the major heavy metal contaminants in roadway runoffs. The use of PCP in roadways and parking lots brings positive impacts for the sake of environmental protection.

Identifying High-Risk Roadways for Infrastructure Investment Using Naturalistic Driving Data

Brian Wolshon, Ph.D., P.E., PTOE
Louisiana State University
October 2013 - June 2015

The state-of-the-practice for most municipal traffic agencies seeking to identify high-risk road segments has been to use prior crash history. While historic traffic crash data is recognized to be valuable in improving roadway safety, it relies on prior observation rather than future crash likelihood. Recently, however, researchers are developing predictive crash methods based on "abnormal driving events." These include abrupt and atypical vehicle movements thought to be indicative of crash avoidance maneuvers and/or near-crashes. Because these types of near-crash events occur far more frequent than actual crashes, it is hypothesized that they can be used as an indicator of high-risk locations and, even more valuably, to identify where crashes are likely to occur in the future. Statistical analyses revealed that clusters of high magnitude jerk events while decelerating were significantly correlated to long-term crash rates at these same locations. These significant and consistent relationships between jerks and crashes suggest that these events can be used as surrogate measures of safety and as a way of predicting safety problems before even a single crash has occurred.

In-Situ Monitoring and Assessment of Post Barge-Bridge Collision Damage for Minimizing Traffic Delay and Detour

Wei Zheng, Ph.D., P.E.
Jackson State University
July 2014-June 2016

Piers of bridges across major navigation waterways frequently suffer from barge collisions, resulting in the closure of both bridges and waterways to traffic for assessing the potential damage. Promptly and accurately locating potential collision damage locations provides the basis for further quantifying the damage extent and facilitating the informative decision-making on the operation of highway and navigation channels, thus can significantly reduce the economic losses resulted from unnecessary closure. This project developed an efficient in-situ monitoring and data processing scheme for assisting bridge professionals to reliably assess the barge-bridge collision damage and make prompt and informative decision on the operation the bridge and navigation waterways. Once a barge-bridge collision event happens, field dynamic measurements can be collected from the collided bridge structure with the sensor network. The best feature vectors were extracted and input into the best classification models of each of the trained classifiers. With the identified threshold of each classifier, the prediction probability of the damage locating in each of the sub-regions were determined.

LNG Bunkering for Marine Vessels at the Port of New Orleans: Siting and Facility Components

Bethany Stich, Ph.D.
James R. Amdal, Sr.
University of New Orleans
April 2014-January 2016

The University of New Orleans Merritt C. Becker Transportation Institute was approached by the Port of New Orleans in 2014 to develop an assessment of best practices regarding the construction of shoreside Liquefied Natural Gas (LNG) bunkering facilities and the overall feasibility of the LNG fueling facility. When this request was made, the maritime industry was expected to convert their fleets from diesel to LNG, due to fuel cost savings and in compliance with planned environmental regulations. However, when OPEC began dramatically decreasing the price of crude oil in the mid-2010s, these cost incentives ceased to exist, especially the economic factor. The best recommendation that can be made from this research at present is for the Port of New Orleans to join with the International Chamber of Shipping in encouraging the International Maritime Organization (IMO) division of the United Nations to continue taking the lead in globally-applied emissions standards. As the shipping industry is committed to the most rapid reduction possible of its share of greenhouse gas emissions, the transfer of the global shipping fleet to LNG is the most efficacious way to attain this end. Therefore the Port is best advised to aggressively support an IMO-derived driven global implementation of policies which would make this fleet conversion ultimately more cost effective than continued reliance upon cheap diesel as a marine fuel.

Multimodal Transport and TransLoad Facilities in Arkansas

Justin R. Chimka, Ph.D.
University of Arkansas
July 2014 - December 2014

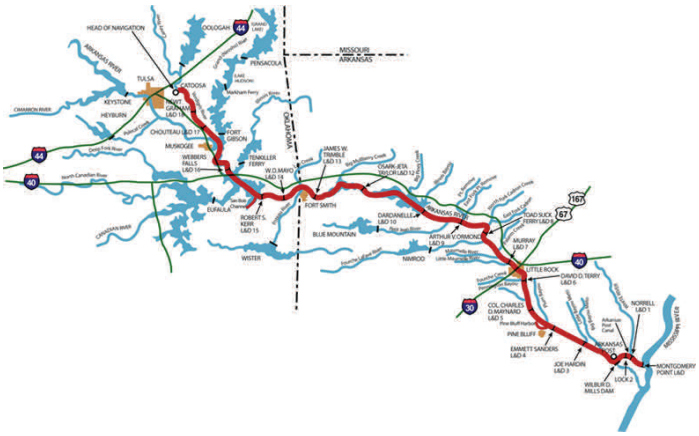
National priorities include building a clean and efficient 21st century transportation sector, and multimodal transportation is one of five Transportation System Efficiency strategies at the U.S. Department of Energy. However, additional multimodal transport may require added transload facilities where freight is moved from truck to railcar or vice versa. Greater than 550 short line and regional railroads operating in 49 states account for almost 30% of the U.S. rail network. These small businesses compete and cooperate with trucking interests to cost-efficiently connect local economies with the larger Class I railroad system. With three Class I railroads and 24 short lines in Arkansas, research finds the state may be poised to ease state highway congestion, safeguard the environment, and support local economies by adding transload facilities.

Optimal Dredge Fleet Scheduling within Environmental Work Windows

Chase Rainwater, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas
August 2014-August 2016

The U.S. Army Corps of Engineers (USACE) annually dredges hundreds of navigation projects through its fleet of government dredges and individual contracts with private industry. This project examined the decision of allocating dredge resources to projects system-wide under necessary constraints including environmental restrictions concerning when dredging can take place due to migration patterns of turtles, birds, fish, and other wildlife, dredge equipment resource availability, and varying equipment productivity rates that affect project completion times. Building on previous research with the USACE, this project has already been successful in applying recently developed scheduling optimization tools to provide comprehensive sensitivity analysis regarding the impact of vary-

Photo courtesy of USACE



ing dredge job sizes, available dredge equipment and the size of environmental windows. Beyond sensitivity analysis, this project has expanded optimization tools to allow for multiple dredge resources to work on a single job, resources that dredge in non-consecutive intervals and environmental windows to be enforced in a dredge-specific fashion. The impact of the implementations in this work can measured quantitatively. However, of equal importance is the impact of this work on the future of decision analysis within USACE. After initial success with the base model, maritime professionals were intrigued by the use of operations research to aid in their decision process. The potential of the initial tool was met with concern over the fact that many realistic components were not considered. The main impact of this project is that every concern presented by USACE has now been addressed from a modeling perspective. The decision makers now understand that optimization tools can be flexible and extendable and, with the appropriate amount of attention, complex challenges can be modeled.

Regional Economic Impact Study of the McClellan-Kerr Arkansas River Navigation System

Heather Nachtmann, Ph.D.
University of Arkansas
April 2014 - August 2015

In this research funded by the Arkansas State Highway and Transportation Department as a MarTREC match project, we implemented a multiregional social accounting matrix framework to estimate the economic impacts of the McClellan-Kerr Arkansas River Navigation System (MKARNS) activities on the study regions of Arkansas, Oklahoma, Kansas, Missouri, Texas, and the rest of the United States. Our study considers economic impacts from 1) Hydropower Energy Generation, 2) USACE O&M Expenditures, 3) Private Sector Investment Expenditures, 4) Port Activities, 5) Shippers' Activities, 6) Transportation Cost Savings, and 7) Recreation Benefits. We combined our analysis with a 2014 Oklahoma Department of Transportation study led by Dr. Dennis Robinson of University of Arkansas - Little Rock and found that the total economic impacts of the MKARNS nationwide are $8.5 billion in sales, $4.3 billion in gross domestic product (GDP), and $2.5 billion in labor income. In addition, 55,872 jobs are created due to the activities related to the MKARNS. Port Activities are the largest component of the total economic impacts of the MKARNS followed by Shippers' Activities and Transportation Cost Savings.

Road Sign Recognition during Computer Testing versus Driving Simulator Performance for Stroke and Stroke+Aphasia Groups

Neila J. Donovan, Ph.D.
Louisiana State University
July 2014 - June 2015

Brain damage from stroke can affect physical mobility, sensorimotor, cognition, communication, visual perception, and visual processing which are all critical processes needed for driving. Currently, there is no consistent way to determine when a person can return to driving poststroke. Most driving studies exclude people with poststroke aphasia (PWA). Aphasia may result in the inability to recognize and interpret the words, symbols, and gestures on road signs, which will impact safe driving. A recent study that tested road sign interpretation tasks among groups of healthy and poststroke older drivers assessed the effects of poststroke aphasia on driving. Results showed that aphasia significantly impacted accuracy and response time of road sign interpretation. As language and symbol complexity increased on road signs, the aphasia-affected drivers performed with less accuracy and required more time. Findings suggest further research may show implications for the design of road signs and decision making for healthcare professionals regarding PWA patients.

CENTER FOR TRAINING TRANSPORTATION PROFESSIONALS

Back row—Austin Williams, Frances Griffith, Mary Fleck, and Roselie Conley
Front row—Najma Alam, Stacy Williams, and Diane Allen

The Center for Training Transportation Professionals (CTTP) has had a banner year, holding more certification classes than in any previous year! A total of 44 classes will be offered in 2016, which tops the previous record of 40. An upswing in the state's construction industry and the overall economy are believed to be responsible for the increase, as well as new companies performing work in the state of Arkansas. These companies have also hired a number of new technicians needing certification. The primary courses of Basic Aggregates, Concrete Field Testing, Hot Mix Asphalt, Soils, and Concrete Strength Testing, have shown consistent enrollment throughout the year. Numerous requests have been received for the National Pollutant Discharge Elimination System (NPDES) course, in response to an initiative to include more agency personnel, contractors and practitioners in this certification. Laboratory certification has also indicated solid trends in the industry, with approximately 50 labs renewing certifications, and 6 new labs enrolling in the program.

Online training has gained significant momentum, particularly as a study aid for those attending CTTP training courses. In August, CTTP was pleased to add another full-time staff member to the team. Austin Williams, full-stack web developer, will be responsible for creating customized back-end programming so that CTTP will be able to provide a wider array of online services to technicians and laboratories. This addition will allow the CTTP Online Products Specialist to focus more on the CTTP learning management system, as well as incorporating additional interactive features into the online training experience. CTTP has also been very active with the Technology Transfer (T^2) program, which is managed by the Arkansas State Highway and Transportation Department. So far this year, CTTP has instructed nearly 200 technicians in topics including Asphalt Pavement Maintenance, Stormwater Management, Erosion Mitigation for Unpaved Roads, Safety Countermeasures, and Pavement Management. The pilot course for the Arkansas Unpaved Roads program was held in April, providing required training for the Unpaved Roads grant program, which is administered by the Arkansas Department of Rural Services. Five more courses are scheduled this year in various regions of the state, which will directly support the grant program.

ARKANSAS GOVERNMENT OFFICIALS VISIT CENTER

October 12, 2015
Senator John Boozman visited MBTC and met with center leadership and our student professional society, *Transportation Leaders of the 21st Century.*

November 13, 2015
Congressman Steve Womack spoke about current transportation challenges at our Mack-Blackwell Annual Advisory Board Meeting.

March 4, 2016
Congressman Bruce Westerman listens to Dr. Gary Prinz talk about the center's current and future structural engineering lab research.

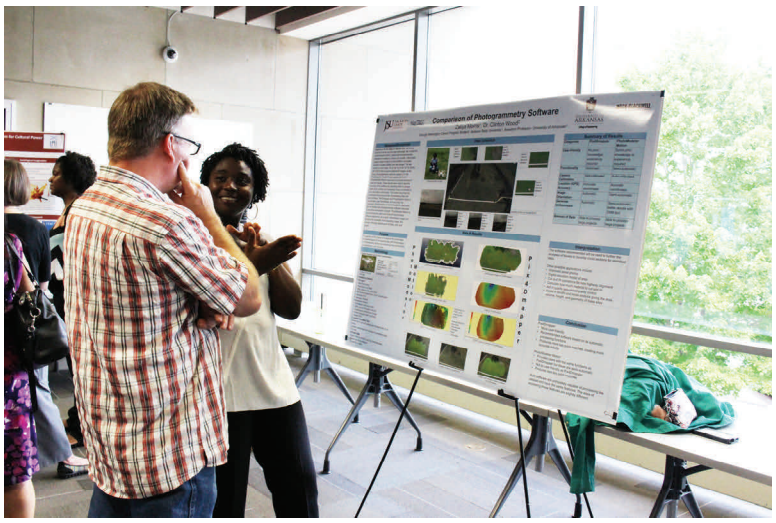
STUDENT ACHIEVEMENTS

Peter Webb was recognized as MarTREC's Outstanding Student of the Year at the 24th Annual Awards ceremony that took place as part of the Council of University Transportation Centers annual banquet in January, 2016. Webb is a Graduate Research Assistant under the supervision of Dr. Bethany Stich, at the Merritt C. Becker, Jr. Transportation Institute at the University of New Orleans. His research seeks to validate the application of CRS & SI technologies to collect data and provide a multi-user, multi-criterion decision-making framework for the development and coordination of E-Navigation technology for the maritime industry with the purpose of improving commercial shipping and safety.

Pictured: Bethany Stich, University of New Orleans; Heather Nachtmann, University of Arkansas; Peter Webb, University of New Orleans; and Carol Short, University of New Orleans

The Mississippi Summer Transportation Institute, a three-week residential program hosted by Jackson State University, was co-funded by Federal Highway Administration, Mississippi Department of Transportation, and MarTREC. This year's cohort consisted of 28 high school students, 50% female and 96% African American. The program introduces a diverse group of motivated pre-college students to the transportation industry and promotes interpersonal skills and exposes students to real-world transportation issues. Students participated in hands-on projects designed to improve their mathematical and scientific abilities as well as their leadership skills.

Pictured: The 2016 MSTI Students



MarTREC and the University of Arkansas were honored to support Zaliya Morris of Jackson State University as our George Washington Carver Research Summer Intern in summer 2016. Morris is a Civil Engineering senior at JSU this Fall. Civil Engineering Assistant Professor Dr. Clint Wood served as Morris' advisor for the summer. Her research, "Comparison of Photogrammetry Software" will be presented at the Transportation Research Board 96th Annual Meeting in Washington D.C.

Pictured: Ms. Zaliya Morris discussing her research poster with Dr. Kevin Hall

STUDENT ACHIEVEMENTS CONTINUED

Pictured: Heather Nachtmann, Richard Deschenes Jr., Kevin Hall, and Jack Buffington

In November 2015, Richard Deschenes, Jr. was awarded the Jack Buffington 8th annual Outstanding Student Poster Award. Deschenes presented his poster on pavement alkali-silica reactions in Arkansas at the 2015 MBTC Advisory Board Meeting and was selected by the MBTC Advisory Board. Deschenes is a civil engineering graduate student working under the supervision of Professor Micah Hale. His work is sponsored by Arkansas State Highway and Transportation Department.

Pictured: Joseph Daniels and Bryan Casillas

Civil Engineering graduate students, Joseph Daniels, Bryan Casillas, and Michael Deschenes have been selected to receive prestigious 2016 Dwight David Eisenhower Graduate Fellowships. The objective of the Dwight David Eisenhower Transportation Fellowship Program is to attract qualified students to the field of transportation and research, and advance transportation workforce development. The program encompasses all modes of transportation and is administered by the Universities and Grants Programs, an intermodal, congressionally mandated program originally authorized by the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 for $2 million annually.

Pictured: Andrew Hindman, Colton Horn and Elkanah Knowles

Andrew Hindman, Colton Horn, and Elkanah Knowles have been selected as 2016 Arkansas Good Roads scholarship recipients. The organization grants scholarships to outstanding civil engineering students in their junior or senior year. Recipients of the scholarship commit to work in the transportation field in Arkansas for a minimum of one year after graduation. The organization creates awareness of the benefits of improving roads, bridges, and other key transportation infrastructure in Arkansas by researching, evaluating and publicizing data focused on transportation.

IN THE NEWS

Frances Griffith, CTTP associate director, has been elected to the board of directors of the American Concrete Institute. She will serve a three year term, which commenced in June 2016. Griffith has been involved with the ACI for more than ten years, starting when she was a civil engineering student at the University of Arkansas. In 2013, she was named an ACI fellow. Her experience with certification has allowed her to make valuable contributions to the organization, as well as to the University of Arkansas through her service on certification program committees. For the last 17 years, she has coordinated Concrete Field Testing certification programs for students in the civil engineering department, enabling these students to develop skills for future research and employment opportunities. She is the first woman to chair a certification committee and receive the institute's Certification Award.

Micah Hale, professor of civil engineering, has been selected as head of the civil engineering department. Hale began the new position on August 15, 2016. Hale has been with the University of Arkansas since 2002. In his research, he focuses on improving the performance of concrete and developing industry standards for new types of concrete. One of his most recent projects involved finding a solution to cracking caused by a process called alkali-silica reaction, which has been compromising parts of Interstate 49 south of Fayetteville. Hale received his bachelor's, master's and doctorate degrees from the University of Oklahoma. He has received the George D. Nasser Award from the Precast/Prestressed Concrete Institute, the Charles and Nadine Baum Award for Teaching from the University of Arkansas, and the Outstanding Teacher Award from the Department of Civil Engineering. He is a fellow of the American Concrete Institute, and was selected to participate in the National Academy of Engineering's Frontiers of Engineering Education symposium in 2010.

Heather Nachtmann, professor of industrial engineering, associate dean for research for the College of Engineering, and MarTREC director was awarded the title of Fellow by the Institute of Industrial and Systems Engineers and was recognized by the University of Arkansas Top 15 in 2015 class of research award recipients. The award of Fellow is the highest classification of IISE membership, and it is awarded to outstanding leaders of the profession who have made significant, nationally recognized contributions to industrial engineering. The offices of the Provost and Vice Chancellor for Academic Affairs and Vice Provost for Research and Economic Development recognized faculty and staff researchers who were the University's most highly funded in fiscal year 2015. As a group, the 15 faculty and staff researchers accounted for more than half of the University of Arkansas' total external research funding of $63.7 million in fiscal year 2015.

Dr. Jingjing Tong, University of Arkansas graduate student alumnae, was honored at the October 2015 American Society for Engineering Management Annual conference in Indianapolis, Indiana. Tong was named first runner-up 2015 Best Dissertation Award Winner. Tong's dissertation, "Disruption Response Support for Inland Waterway Transportation," was chaired by Heather Nachtmann, associate dean for research in the College of Engineering, professor of industrial engineering, and MarTREC director. Tong is an assistant professor in the Department of Polytechnic Studies at Southeast Missouri State University.

Pictured: Heather Nachtmann, Jingjing Tong, Kim Needy and Ed Pohl

DAN FLOWERS DISTINGUISHED LECTURE

November 12, 2015

Gene Higginbotham (pictured)
Executive Director, Arkansas Waterways Commission
and Heather Nachtmann Ph.D., MarTREC Director

Regional Economic Impact Study for the McClellan Kerr Arkansas River Navigation System

April 14, 2016

Robert Sinn, P.E. (pictured)
Principal and Building Structure Practice Leader, Thornton Tomasetti

Jeddah Tower, The Next World's Tallest Building and the First Man-Made Structure to Reach a Height of one Kilometer

MarTREC STAFF

Heather Nachtmann, Ph.D.
University of Arkansas
Director

Kevin D. Hall, Ph.D., P.E.
University of Arkansas
MBTC Executive Director

Amy M. Shell, M.S.
University of Arkansas
Center Coordinator

Bethany Stich, Ph.D.
University of New Orleans
Site Director

Feng Wang, Ph.D., P.E.
Jackson State University
Site Director

Brian Wolshon, Ph.D., P.E., PTOE
Louisiana State University
Site Director

CONTACT INFO

4190 Bell Engineering Center
University of Arkansas
Fayetteville, Arkansas 72701
Phone: 479.575.6021
Email: martrec@uark.edu

Cover photo courtesy of AHTD